




# Recycler Lattice Up the Main Injector ramp

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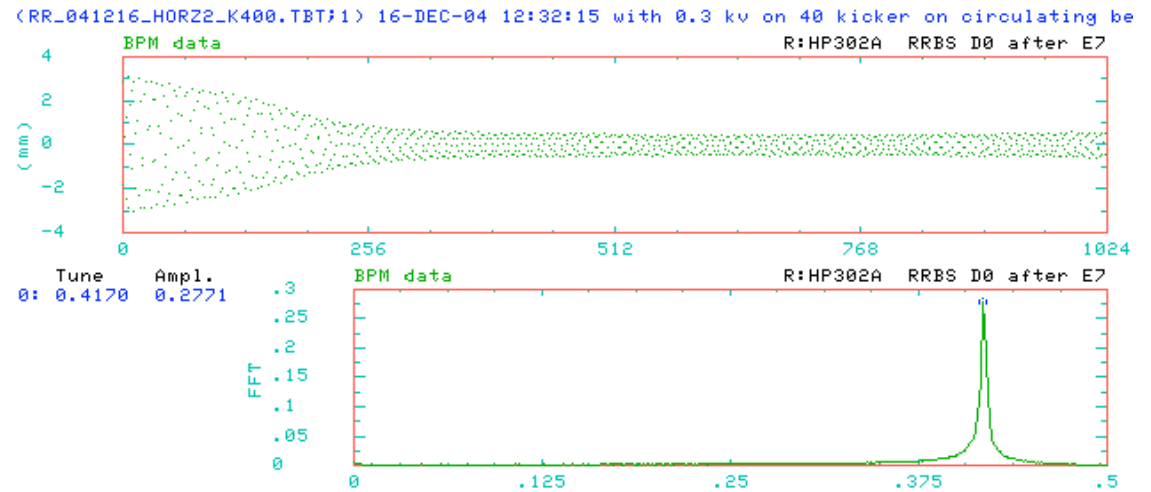
# The study

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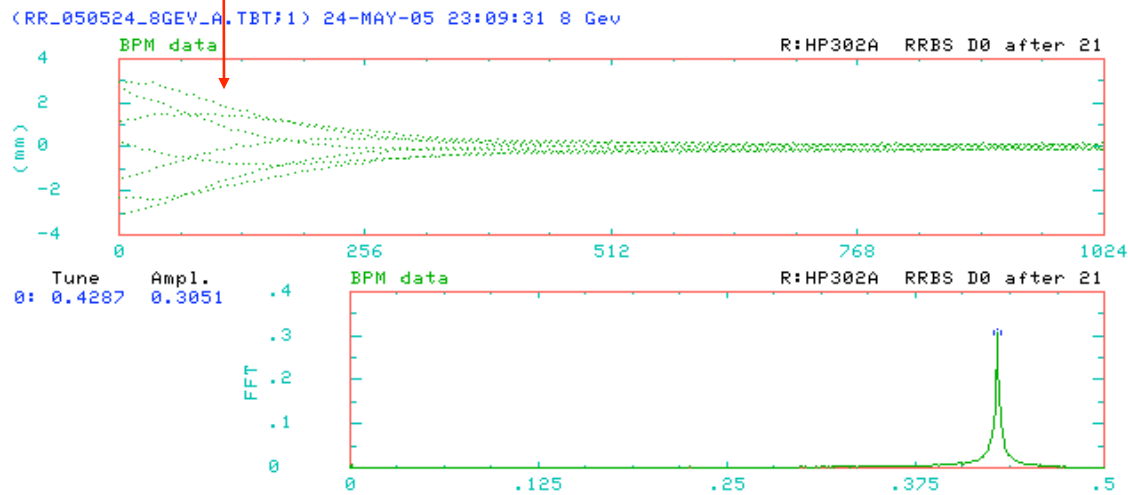
- Objectives
  - To compare the measured beta function during MI ramp
    - ✓ 8 GeV and 120 GeV.
- Measurements
  - Ping beam with 40 kicker
  - Set kicker timing relative to MI ramp.
  - Horizontal plane data only.
- Analyze data
  - Use only the first 100 turns.
  - Re-analyzed December data similarly.

# TBT data

## December data



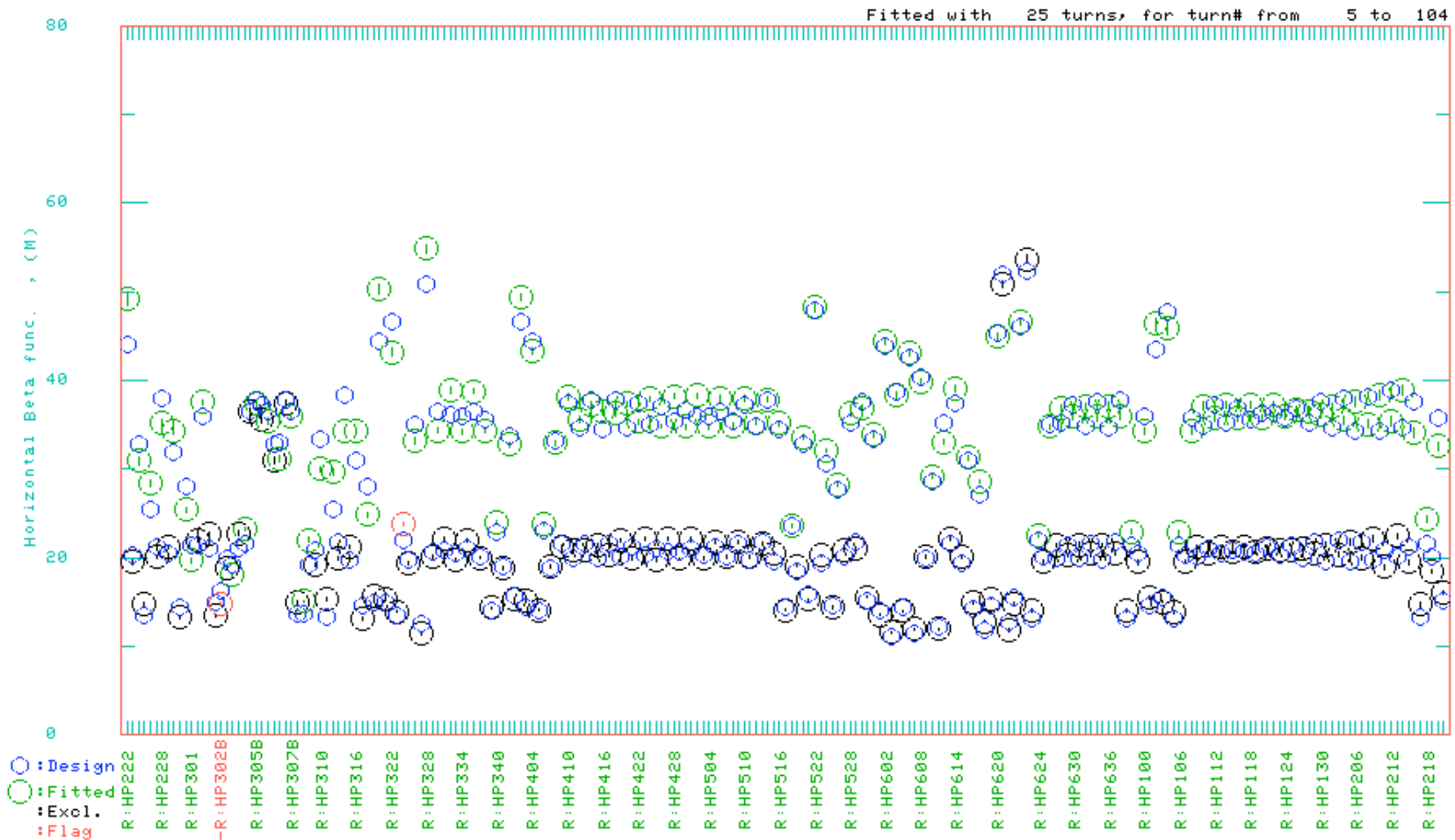
Use only the first  
100 turns of data



data taken on  
5/24/05

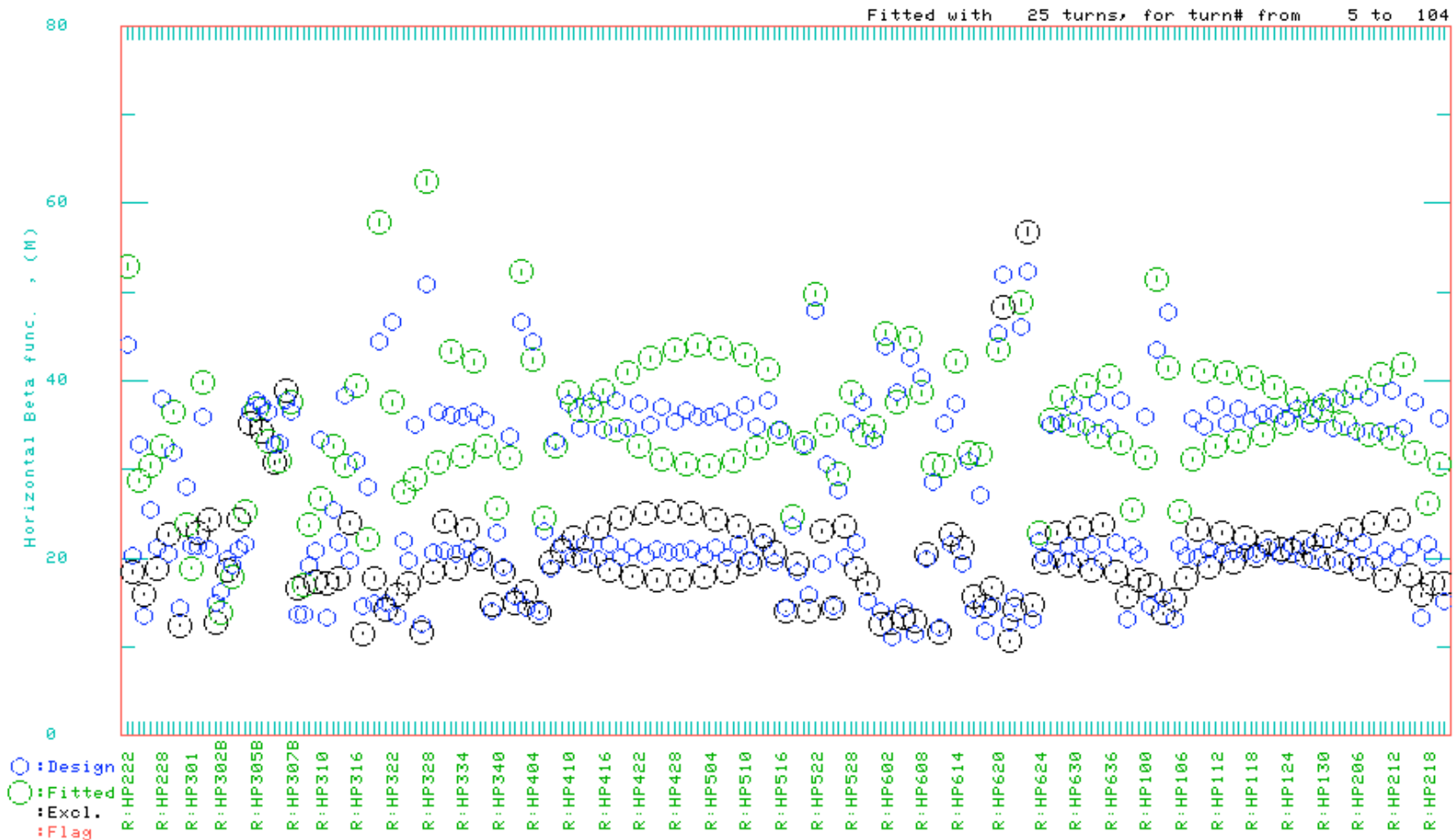
# Horizontal beta function from December, 2004

(RR\_041216\_HORZ2\_K400.TBT;1) 16-DEC-04 12:32:15 with 0.3 kv on 40 kicker on circulating beam



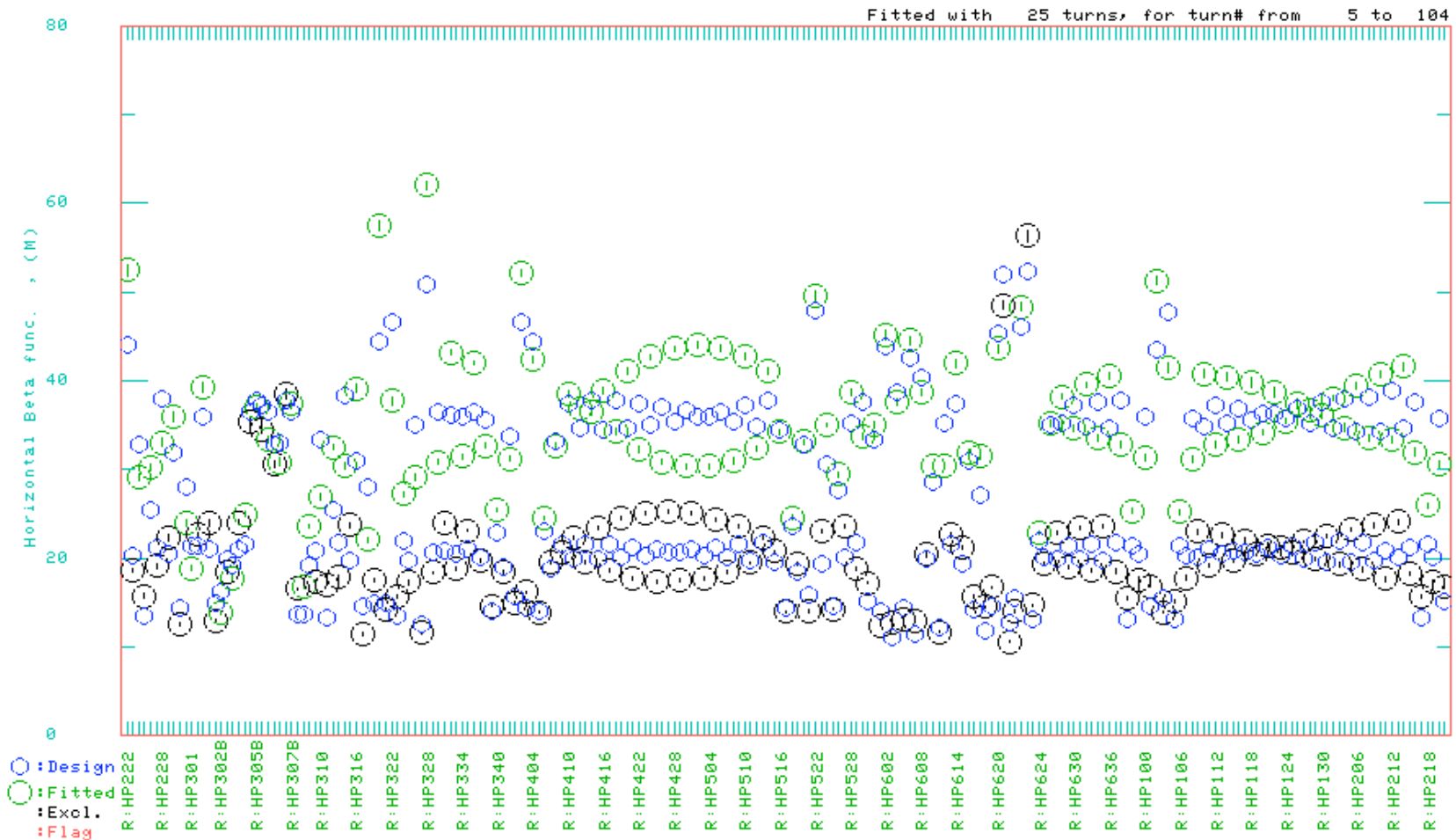
# Horizontal beta function with MI at 8-GeV

(RR\_050524\_8GEV\_A.TBT/1) 24-MAY-05 23:09:31 8 Gev

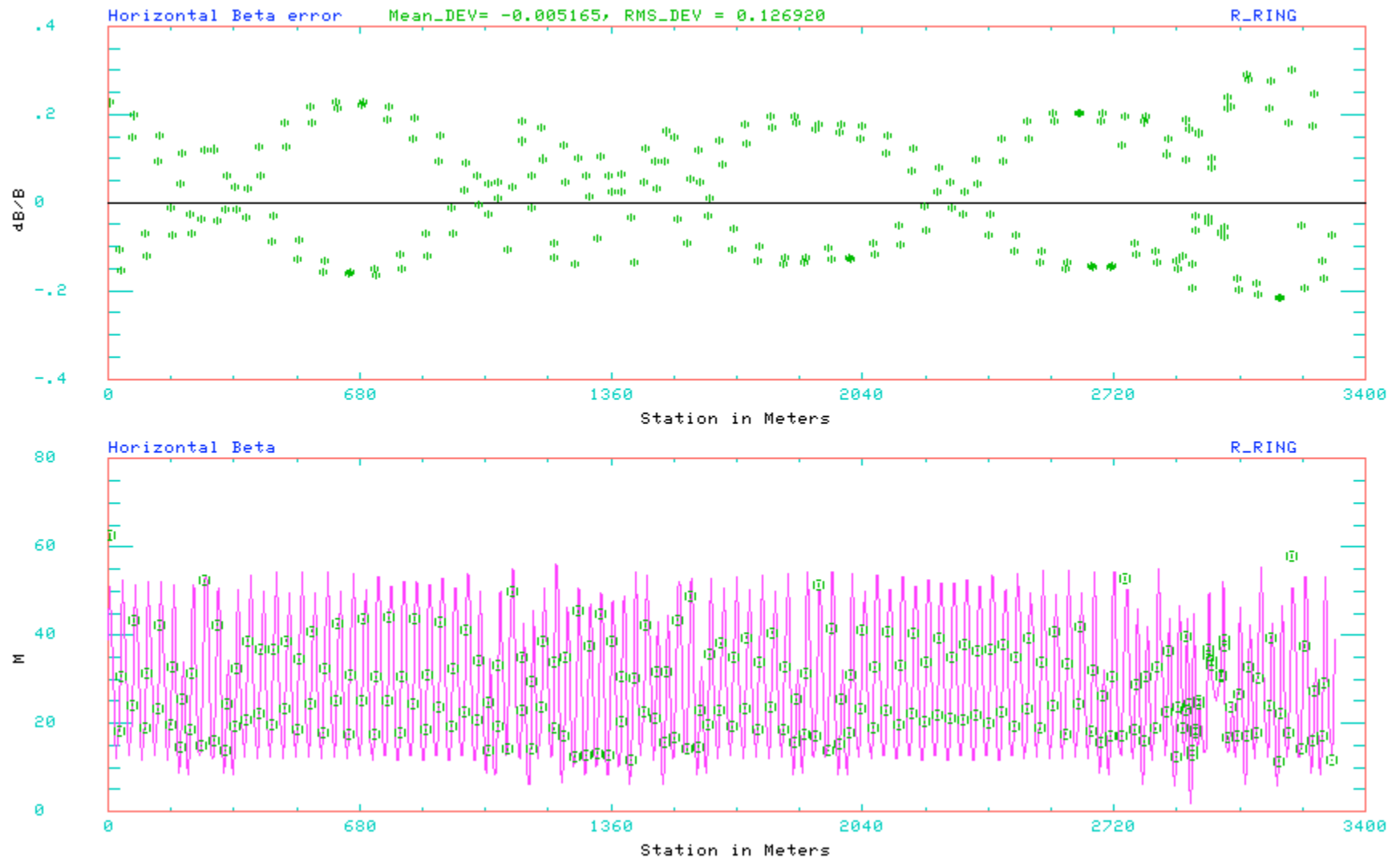


# Horizontal beta with MI at 120 GeV

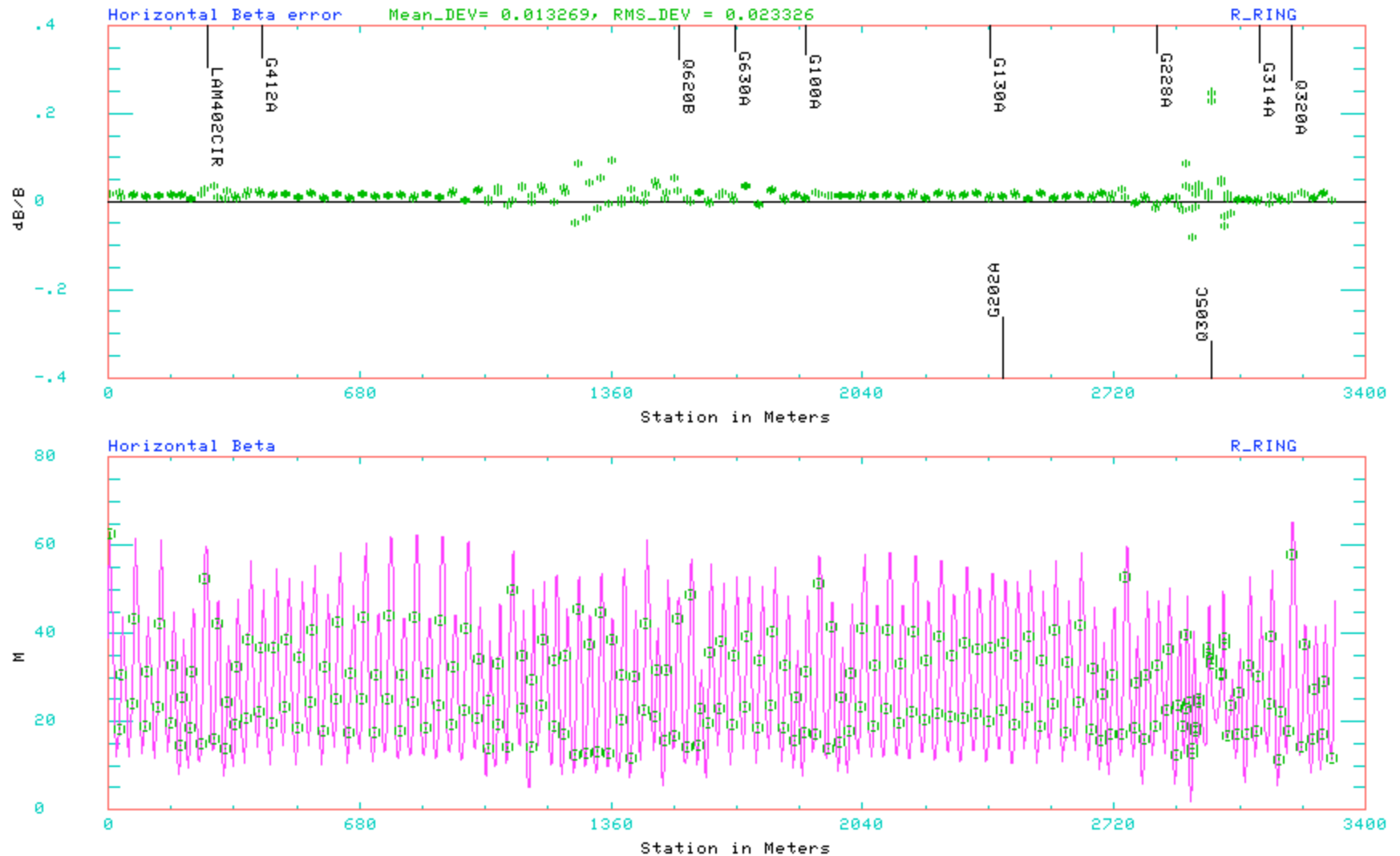
(RR\_050524\_120G\_B.TBT/1) 24-MAY-05 23:19:34 120 GeV



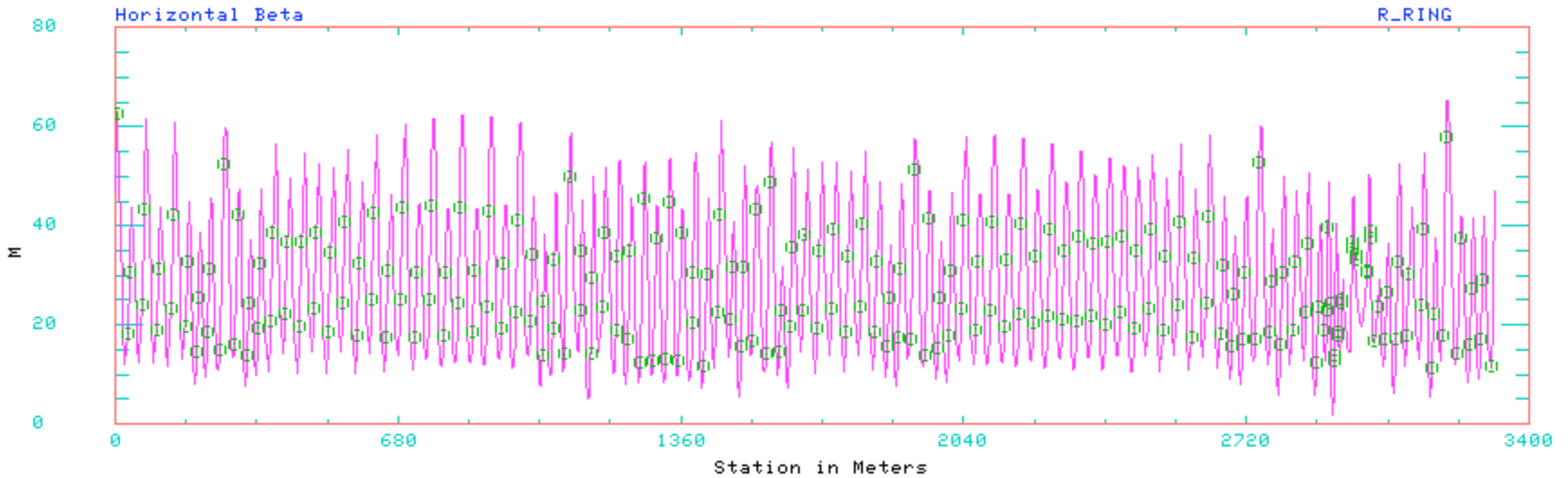
# Beta wave as compared to R90 calculation



# Matching the beta function with RR as transfer line







# Initial lattice parameters used and quad field errors found

← Design → As transfer line → As closed ring

**Design Lattice parameters**

```
Select: [R_RING ] as [Synchrotron ]
Start at element: [MLAM328I ] for [Proton ]
*Track: [Lattice function] at ( 8 )
```

Lattice	Horz	Vert
Phase: ( 25.4305 )	( 24.4095 )	
Beta: ( 39.4259 )	( 20.3527 )	
Alpha: (-2.08034 )	( 1.32921 )	
eta: (-1.72741 )	( 0 )	
etap: (-.0728 )	( 0 )	

Beam  
Position: ( 0 ) ( 0 )  
Angle: ( 0 ) ( 0 )

Emi

DB device page

DB_name	Setting	prev_set	reading	prev_read
K1LAM402 KG/M	0		.05	0
x_K1G412	3.356663		3.386663	3.356663
X_Q620B AMPS	26.26904		26.46904	26.26904
x_K1G630	3.359361		3.409361	3.359361
x_K1G100	6.68329		6.73329	6.68329
K1G130A	3.357642		3.337642	3.357642
x_K1G202	3.355536		3.375536	3.355536
x_K1G228	3.35266		3.25266	3.35266
X_Q305C Amps	-21.97095		-19.97095	-21.97095
x_K1G314	3.358561		3.258561	3.358561
X_Q320A AMPS	26.27145		26.07145	26.27145

<Exit>

**As transfer line Lattice parameters**

```
Select: [R_RING ] as [Transfer line]
Start at element: [G328A ] for [Proton ]
*Track: [Lattice function] at ( 8 )
```

Lattice	Horz	Vert
Phase: ( 25.4415 )	( 24.4068 )	
Beta: ( 49.1258 )	( 18.7944 )	
Alpha: (-2.58034 )	( 1.24683 )	
eta: (-1.75785 )	( 0 )	
etap: (-.072817 )	( 0 )	

Beam  
Position: ( 0 ) ( 0 )  
Angle: ( 0 ) ( 0 )

Emi

DB device page

DB_name	Setting	prev_set	reading	prev_read
K1LAM402 KG/M	0		.05	0
x_K1G412	3.356663		3.386663	3.356663
X_Q620B AMPS	26.26904		26.46904	26.26904
x_K1G630	3.359361		3.409361	3.359361
x_K1G100	6.68329		6.73329	6.68329
K1G130A	3.357642		3.337642	3.357642
x_K1G202	3.355536		3.375536	3.355536
x_K1G228	3.35266		3.25266	3.35266
X_Q305C Amps	-21.97095		-20.17095	-20.97095
x_K1G314	3.358561		3.258561	3.358561
X_Q320A AMPS	26.27145		26.07145	26.27145

<Exit>

**As closed ring Lattice parameters**

```
Select: [R_RING ] as [Synchrotron ]
Start at element: [G328A ] for [Proton ]
*Track: [Lattice function] at ( 8 )
```

Lattice	Horz	Vert
Phase: ( 25.4421 )	( 24.3954 )	2π
Beta: ( 49.0833 )	( 16.7415 )	M
Alpha: (-2.57717 )	( 1.0043 )	
eta: (-1.73023 )	( 0 )	M
etap: (-.072817 )	( 0 )	

Beam  
Position: ( 0 ) ( 0 )  
Angle: ( 0 ) ( 0 )

Emi

DB device page

DB_name	Setting	prev_set	reading	prev_read
K1LAM402 KG/M	0		.05	0
K1LAM214 KG/M	0		.02	.03
K1LAM328 KG/M	0		.27	.23

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Transfer line fit result

Closed ring fit result

# Conclusion

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- Lattice function
  - Lattice is different from that of December, 2004.
    - ✓ Beta wave around 20-30 % from design.
  - No gross difference between MI at 8-GeV and at 120 GeV
- Potential quadrupole field error locations
  - Lambertsons
    - ✓ LAM328, LAM402, LAM214
  - Quads
    - ✓ Q305C, Q620B, Q320A
  - Gradient magnets
    - ✓ G228, G314
    - ✓ G412, G630, G100, G130, G202